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EXAMINER

WARREN, MATTHEW E

ART UNIT PAPER NUMBER

2815

DATE MAILED: 12/10/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

## Office Action Summary

Application No.

10/628,372

Applicant(s)

NAKAMURA ET AL.

Examiner

Matthew E Warren

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

### Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

### Status

- 1) ☒ Responsive to communication(s) filed on 04 November 2004.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

### Disposition of Claims

- 4) ☒ Claim(s) 1-27 is/are pending in the application.
- 4a) Of the above claim(s) 24-27 is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-20 and 23 is/are rejected.
- 7) ☒ Claim(s) 21 and 22 is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

### Application Papers

- 9) ☒ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 29 July 2003 is/are: a) ☐ accepted or b) ☒ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

### Priority under 35 U.S.C. § 119

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some \* c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
  2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

### Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)  
Paper No(s)/Mail Date 7/29/03.
- 4) ☐ Interview Summary (PTO-413)  
Paper No(s)/Mail Date. \_\_\_\_\_.
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: \_\_\_\_\_.

### **DETAILED ACTION**

This Office Action is in response to the Election filed on November 4, 2004.

#### ***Election/Restrictions***

Applicant's election of Group I, claims 1-23 in the reply filed on November 4, 2004 is acknowledged. Because applicant did not distinctly and specifically point out the supposed errors in the restriction requirement, the election has been treated as an election without traverse (MPEP § 818.03(a)).

#### ***Drawings***

Figures 23 and 24 should be designated by a legend such as --Prior Art-- because only that which is old is illustrated. See MPEP § 608.02(g). Corrected drawings in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. The replacement sheet(s) should be labeled "Replacement Sheet" in the page header (as per 37 CFR 1.121(d)) so as not to obstruct any portion of the drawing figures. If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

#### ***Specification***

The title of the invention is not descriptive. A new title is required that is clearly indicative of the invention to which the claims are directed.

***Claim Rejections - 35 USC § 112***

The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Claims 1-12 and 17 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. In claim 1, the limitation of "the first support plug...having a second Young's Modulus" renders that claim indefinite. There is no reference to a first Young's Modulus, thus it is uncertain if there is another dielectric with a first Young's Modulus or if the first plug has a first and second Young's Modulus. For purposes of examination, the limitation will be interpreted to mean that "the first support plug...has a Young's Modulus."

Claim 17 includes the limitation of "the second support plug" in line 9. There is insufficient antecedent basis for this limitation in the claim.

***Rejections - 35 USC § 102***

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 1 and 9, as far as understood, are rejected under 35 U.S.C. 102(b) as being anticipated by Dawson et al. (US 5,998,293).

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In re claim 1, Dawson et al. shows (fig. 2) a semiconductor device comprising: a foundation having a first conductive region (24b); an interconnection layer (12a) provided separate from the foundation; a first region occupying a range from the foundation to the interconnection layer, and filled with gas (air gaps) or provided with a first interlayer dielectric film; a conductive first connection plug (18c) provided in the first region, and electrically connecting the first conductive region and the interconnection layer; and a dielectric first support plug (22) provided in the first region, the gas being filled or the first interlayer dielectric film being provided between the first connection plug and the first support plug, the first support plug extending from the interconnection layer to the foundation and having a Young's modulus.

In re claim 9, Dawson discloses (col. 5, lines 26-28) that the first support plug consists of SiN.

### ***Claim Rejections - 35 USC § 103***

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claim 1-8 and 13-19, as far as understood, are rejected under 35 U.S.C. 103(a) as being unpatentable over the Applicant's Prior Art Figure 23 (APAF) in view of May et al. (US 6,566,244 B1).

In re claims 1, 3, and 13, the APAF 23 shows semiconductor device comprising: a foundation having a first conductive region (102b); and a first interlayer dielectric film (103) provided on the foundation, having a first through hole (hole of 105b) ranging from its upper surface to the foundation and a second through hole (hole of 105a) ranging from its upper surface to the first conductive region, and having a first Young's modulus. A conductive first connection plug (105b) is provided in the second through hole; and an interconnection layer (104b) provided on the first interlayer dielectric film, extending from the first connection plug and electrically connected with the first conductive region via the first connection plug. The APAF shows all of the elements of the claims except the dielectric first support plug in the first through hole. May et al. shows (fig. 1) a foundation having a conductive region (2) and a first interlayer dielectric (20) provided on the foundation. A dielectric support plug is provided in a through hole (26b) and has a second Young's modulus higher than the first Young's modulus of the interlayer dielectric (col. 2, lines 25-30). With such a configuration, the dielectric support plugs provide mechanical reinforcement to portions of the interlayer dielectric material between the conductive plugs (24). Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the interlayer dielectric film of the APAF by adding dielectric support plugs between connection plugs or vias as taught by May to provide reinforcement to the interlayer.

In re claims 2, 4, 14, and 15, neither reference discloses the specific second Young's modulus. Such a limitation is not distinguishable over the cited art because one of ordinary skill in the art would find a material having any desired Young's modulus that

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would provide adequate reinforcement of an interlayer dielectric. It has been held that discovering an optimum value of a result effective variable involves only routine skill in the art. *In re Boesch*, 617 F.2d 272, 205 USPQ 215 (CCPA 1980).

In re claims 5 and 16, May discloses (col. 1, lines 44-64) that the first interlayer dielectric film consists of a low k material having a dielectric constant of about 2.6 (approximately ~ 2.9).

In re claims 6, 7, and 17, the APAF shows that the foundation has a second conductive region (102c), the first interlayer dielectric film has another through hole (hole of 105b) ranging from its upper surface to the second conductive region. A conductive second connection plug (105b) is provided in the another through hole (third hole when combined with May). The interconnection layer extends on the second connection plug and is electrically connected with the second conductive region via the second connection plug. When May is combined with the APAF, the first support plug is positioned between the first and second connection plugs along the interconnection layer.

In re claim 18, May shows (fig. 1) that the first interlayer dielectric film has a fourth through hole (26c), a dielectric second support plug (21) and having a Young's modulus higher than the first interlayer dielectric film (col. 2, lines 25-30). The second support plug is positioned between the first support plug (in 26b) and the second connection plug (24 on the right). When combined with the APAF the interconnection layer extends on the second support plug.

In re claim 8 and 19, neither reference discloses the interlayer dielectric film having fifth to  $n+2$ -th through holes and third to  $n$ -th support plugs, but that limitation is not distinguishable over the cited art. One of ordinary skill in the art would add additional through holes and support plugs to provide additional support and reinforcement to the interconnection layer. It has been held that mere duplication of the essential working parts of a device involves only routine skill in the art. *In re Harza*, 274 F.2d 669, 124 USPQ 378 (CCPA 1960). See also MPEP 2144.04 VI. (B). As for the limitation of the total area of the support plugs being 1 to 80 % of the area of the interconnection layer facing the foundation, that limitation is also not distinguishable over the cited art. One of ordinary skill in the art would increase or decrease the total area of the support plugs to be a certain percentage of the area of the interconnection layer to provide the desired support and reinforcement to the interconnection layer.

Claims 9, 12, 20, and 23 are rejected under 35 U.S.C. 103(a) as being unpatentable over Applicant's Prior Art Figure 23 (APAF) in view of May et al. (US 6,566,244 B1) as applied to claims 1 and 13 above, and further in view of Farrar (US 5,994,777).

In re claims 9 and 20, the APAF in view of May et al. shows all of the elements of the claims except the specific materials of the support plug. Farrar discloses (col. 12, lines 25-31) that dielectric support structures (804 in figs. 13b-g) comprise SiO or SiN to support conductive bridge structures. Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the support plugs of



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the APAF and May by specifically using SiN as taught by Farrar to provide adequate support for a conductive bridge or interconnect structure.

In re claims 12 and 23, the APAF in view of May et al. does not specifically disclose that a second interlayer dielectric film is provided on the interconnection layer. Such a limitation is not distinguishable over the cited art because it is well known in the art to provide additional layers of interlayer dielectric and interconnect material for multiple wiring levels. However, Farrar additionally discloses (col. 12, lines 17-21) that steps are repeated for additional wiring levels which include forming an interlayer dielectric on the lower conductor layer (812). Therefore it would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the device of the APAF and May by adding a second interlayer dielectric film on the interconnection layer as taught by Farrar to form additional wiring levels above the first interconnect layer.

### ***Allowable Subject Matter***

Claims 10 and 11 were rejected under the 35 USC 112 rejection above but contain allowable subject matter. Claims 10 and 11 would be allowable if the 112 rejection were overcome and rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Claims 21 and 22 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

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### **Conclusion**

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Zhao (US 6,211,561 B1) and Grill et al. (US 6,017,814) also show conductive interconnect structures having dielectric support plugs.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew E Warren whose telephone number is (571) 272-1737. The examiner can normally be reached on Mon-Thur and alternating Fri 9:00-5:00pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Tom Thomas can be reached on (571) 272-1664. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

MEW  
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December 7, 2004

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